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**Test Method for Tensile Strength
of Fiber Composites under Ultrahigh
Temperature and Oxidizing Environment**

超高温氧化环境下纤维复合材料 拉伸强度试验方法

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Test Method for Tensile Strength of Fiber Composites under Ultrahigh Temperature and Oxidizing Environment

1 Scope

This Standard specifies the test principle, apparatus, sample, test procedures, results, calculation and test report for the tensile strength test of fiber composites under ultrahigh temperature and oxidizing environment.

This Standard is applicable to the tensile strength test of the fiber braided composites under different oxygen partial pressure environments from 1500°C~2200°C; other types of materials and the tensile strength test under high temperature of 1500°C below shall be referred to.

2 Normative References

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) are applicable to this document.

GB/T 1446-2005 The Generals of Test Methods for Properties of Fiber-Reinforced Plastics

GB/T 16491 Electronic Universal Testing Machines

3 Terms and Definitions

The following terms and definitions are applicable to this document.

3.1 Ultrahigh temperature

Temperature of 1500°C and above.

3.2 Uniform temperature zone

The working area in the middle of the sample with the same cross-sectional

6.3 Sample quantity

Under the same test conditions, the number of effective samples shall be no less than 5 pieces.

NOTE: If performing a statistical analysis of the intensity (e.g.: Weibull statistical analysis), then at least 30 samples are required.

7 Test Procedures

7.1 Measuring sample size

Inspect the sample before the test; use the Vernier caliper with an accuracy of 0.02mm to measure the size of uniform temperature zone of the sample. The thickness and width of the cross-section of the sample is measured at both ends and in the middle of the uniform temperature zone, then take the average value. The sample surface shall not be damaged during the measuring period.

7.2 Installation of the sample

7.2.1 Install the fixture.

7.2.2 For the samples that can be directly inductively heated, insert the sample directly into the induction coil. For the samples that cannot be directly inductively heated, firstly, place the sample into the graphite heating sleeve, then insert it into the induction coil; ensure the graphite sleeve flush with the induction coil.

7.2.3 Install the specimen into the fixture; adjust the sample, and keep the gap between the sample and the sleeve about 2mm~5mm. The infrared thermometer, temperature measuring window and graphite sleeve opening shall be in a straight line.

7.3 Heating and adjusting the partial pressure

7.3.1 Adjust the two-dimensional sliding platform; so that the temperature measuring point of the infrared thermometer is near the center of the uniform temperature zone of the sample.

7.3.2 Vacuum the heating furnace to 1×10^{-2} Pa below at room temperature; keep vacuum or fill with inert gas.

7.3.3 Heat the sample by manual or automatic temperature control mode; the recommended temperature rising rate is $30^{\circ}\text{C/s} \sim 100^{\circ}\text{C/s}$; keep for 1 min, when the setting temperature is reached.

7.3.4 After the setting test temperature is reached, adjust the gas pressure in the heating furnace to the setting value according to the test required oxygen partial

pressure. Generally, it is 0.1Pa ~ 10000Pa. Or avoid the position of the inlet or outlet of the heating furnace; use the oxygen partial pressure meter to measure the oxygen partial pressure in the chamber of the furnace.

7.3.5 The sample directly heated by electromagnetic induction is kept warm for 3min; or the sample heated by the graphite sleeve radiation is kept warm for 5min. During the heat preservation period, move the two-dimensional sliding platform to monitor the surface temperature of the sample; the length of the lateral and longitudinal movement shall be no less than 6mm. Keep the temperature deviation of the uniform temperature zone of the sample not exceeding 3% of the setting temperature value.

7.4 Test

Adopt the displacement control loading mode to impose the tensile load on the sample; the loading speed is of 1.0mm/min ~ 3.0mm/min till the sample is damaged. Record the load-time curve and the maximum load value.

7.5 Failure mode judgment

If one of the following conditions occurs during the test, then the test data is invalid:

- The fixture is damaged during the test;
- The broken site of the sample is beyond the uniform temperature zone.

8 Results and Calculation

8.1 Tensile strength shall be calculated as per the Formula (1):

$$\sigma_t = \frac{P_{\max}}{b_1 \times h} \dots\dots\dots (1)$$

Where:

σ_t – tensile strength, in MPa;

$P_{\max}$ – maximum load, in N;

b_1 – specimen width, in mm;

h – specimen thickness, in mm.

8.2 The arithmetic mean, standard deviation and dispersion coefficient of tensile strength shall be calculated as per the Clause 6 of GB/T 1446-2005.

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